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ABSTRACT

A case study analyzed the babbling and speech production of an infant, aged 20 to 24 months, whose family members spoke Portuguese, English, and French interchangeably. Focus was on vowel production, choice of lexicon, and the relationship between babbling and speech in the interaction of his languages. The child's utterances were recorded in interactions with family together, with each family member individually, with monolingual English-speaking children, and alone in his room. Results indicate a shift from English to French over the 4-month period. The lexicon included 24 words at 20 months and 98 at 24 months, some with representations in more than one language. The primary language in lexical choices shifted from French dominance to French/English balance and finally a predominance of English words. The French vowel system was dominant. Vowel production followed the choice of target words. Vowel correctness changed distinctly over the taping sessions, with monosyllabic target words pronounced increasingly correctly but with vowels in disyllabic words pronounced with decreasing correctness. The findings support neither a separate-system or single-system hypothesis of language acquisition. The sociophonetic environment appears to have been a critical influence. A 32-item bibliography is included. (MSE)

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Reflection of a Phonologically-Mixed Environment in Early Speech

CHENEY CROW

At what point in a child's development does speech production reflect a particular language system? Mehler et al. (1988) have shown that within four days after birth infants can distinguish their language from other languages, although they cannot distinguish between languages not present in their environment. Cross-linguistic perceptual abilities are also evident, and testable, by six months. Werker has shown (1981, Werker and Tees; 1984, Werker; 1988, Werker), that between seven and ten months infants demonstrate the ability to discriminate between sounds which are not phonemically different in their native languages as well as infants of native speakers of the test language. This ability either declines or is not used after twelve months, an age which frequently corresponds both to the onset of speech and the arrest of production of segments which are not part of the phonetic repertoire of the child's target language(s) (Locke, 1980).

Analyses of the babbling production of children in different language environments have been undertaken to determine the point at which speech production reflects the influence of the input languages in the child's environment. Cross-linguistic studies of babbling have found a "positive correlation between the number of children who produce a sound and its occurrence in the world's languages" (Oller and Eilers 1982). Studies by Eadys (1980), Tuaycharoen (1977), Huber (1970), and deBoysson-Bardies (1981), among others, (reviewed in Locke 1983) have searched for evidence in consonant production of differing babbling patterns between different language communities. These studies are part of an increasing body of evidence which illustrates regularity in the order of acquisition of consonants. The emergence of patterns of consonant production in babbling which concur across languages supports the idea that acquisition of consonant production may be primarily determined by the development and the systematic exploration of the vocal tract and articulators (Locke, 1983, Kent, 1979, 1981). Early vowel production may be subject to these same constraints, as described by Buhr (1980); Bickley (1983); and Bond et al. (1982).

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In 1988, deBoysson-Bardies undertook the study of formant frequencies of the vowel production of 7-9 month old children in monolingual English, French, Arabic and Cantonese language environments. Extensive analysis showed a clear relationship between the vowel production of the children and that of their input languages. This age range, 7-9 months, correlates well with Kent's (1983) statement that the neurological maturation necessary for voluntary motor control of the articulators begins around six months; vowels generally require less complex movement of the articulators than consonants, which might explain their earlier imitation of the linguistic environment. These findings confirm earlier data of Oller and Eilers (1982) indicating the presence, even during babbling, of speech production characteristics that reflect the ambient language.

Vihman (1985) has shown that there is a continuity between speech production in babbling and in speech. She demonstrates clear parallels between the babbling and emergent speech production in children from 10 to 15 months of age. First words, she claims, can be predicted from the babbling patterns of each child. Such "continuity" illustrates that babbling, because it is directed towards eventual speech targets, reflects the ambient language.

Language Differentiation in Bilingual Children

Language acquisition research on multilingual children has revealed inconsistent and conflicting tendencies in their early speech production, characterized by either separation or integration of the different language systems. Separate, independent phonological systems have been observed in the speech production of some bilingual children whose interlocutors addressed them consistently in only one language (Leopold,1949; Taeschner, 1978; Vihman, 1985; and others reviewed in Taeschner, 1983 and Hatch, 1978). Overlapping systems resulting in phonological confusion and inconsistency in the speech production of multilingual subjects was reported by De Matteis (1978) and Ruke-Dravina (1965). Vogel, Burling (1973), Chao (1973), Imedadze (1967) and Swain and Wesche (1973), documented consistent, single phonological systems created from a mixture of the languages of bilingual children.

The disparity in the findings among the studies of phonological systems of bilingual children may be attributed to differences in linguistic input to the child. In a multilingual environment, differentiation between phonological systems might be facilitated

for a child by identification of a single linguistic system for each interlocutor. Conversely, the phonological system of a child regularly subjected to language mixing, or switching, in his sociophonetic environment may be characterized by a mixture of elements from the two languages.

Methodology

Over a four-month period, babbling and speech production were analyzed in a multilingual child, Bruno, from the age of 20 to 24 months. In examining the interaction among his languages, emphasis was put on analysis of his vowel production, his choice of lexicon, and the relationship between his babbling and his speech. The emphasis on vowel production was based on evidence presented by deBoysson-Bardies (1989) that imitation of linguistic environment is evident earlier in vowels than in consonant production. Furthermore, the contrasts between French and English vowels may be more easily ascertained than those between the consonants at this stage of development because characteristics that would differentiate French from English consonant production may be confounded by developmental trends in consonant production. The cross-linguistic regularity of consonant acquisition (reviewed in Locke, 1983) is one reason this analysis concentrated on vowel production.

Language Environment: Bruno lived in an environment where three languages were spoken interchangeably by all family members. His mother, Helene, a native speaker of French, spoke Portuguese and English. These languages exhibited strong influence of French vowel, consonant, and stress systems. Bruno's father is a native speaker of Portuguese. Like Helene, his native language was evident in both his second and third languages, English and French. Unlike his parents, who were both late bilinguals, Bruno's 9-year-old brother, Fabio, spoke French, Portugese and English like a native speaker. In conversation with each other and in addressing Bruno, they all frequently switched languages, even within sentences, so Bruno was exposed to a continual mixture of the three languages. Vowel and stress patterns were produced inconsistently by his parents because of errors and the influence of their native languages on their second and third languages. Therefore, the English which Bruno heard regularly was from three non-native speakers whose vowel, consonant and stress use was uncharacteristic of native-speaker English, which he heard only from Fabio, his brother, and Alexis, his daycare companion.

Duration and Setting of Data-collection: For a four-month period, between the ages of 20 to 24 months, 40-minute bimonthly recordings were made of Bruno's speech, using a Panasonic tape recorder with a Sony ECN-30 electric microphone which was either attached with a clip to Bruno's or the experimenter's clothing, or set on a small microphone stand near his bed. Recordings were made at his home during normal family interaction. Portions of tapes include Bruno's interaction with all family members together, each individual family member, monolingual English speaking children, multilingual family friends, and Bruno alone in his room. Recordings were made in the presence and in the absence of the experimenter.

Method of Transcription: All utterances of the child, both speech and babbling were transcribed phonetically. A reliability check with three other transcribers showed more than 85% agreement on all segments transcribed. For segments on which transcriptions did not concur the transcription of the experimenter was used. Two transcribers were native speakers of English, and the third a native speaker of Italian, who also spoke French. Vowel production in monosyllables and disyllables was analyzed for speech production by a program developed by MacNeilage and Davis, with special additions for inclusion of the French vowels.

Utterances were counted as meaningful words if they appeared at least three times with meaningful intent confirmed by the child's mother, or as babbling. All meaningful words were compared to a phonetic transcription of the target word. Vowels were analyzed for: frequency, correctness, and substitutions in each position of monosyllable and disyllabic words, The vowels analyzed were: i, I, e, ɛ, æ, a, ã, ɔ, ɔ̃, ʌ, ʌ̃, ə, o, u. Frequency of occurrence was compared to the frequency tables for vowels in French and in English, the dominant languages of Bruno's production during these sessions and general tendencies for frequency, correctness and substitution were assessed. Consonant production and stress assignment were examined and compared across languages, as well within different productions of individual lexical items.

Results

The development of Bruno's lexicon showed a shift from French to English over the four-month period. The lexicon included 24 words at the beginning of the taping sessions, and 98 at the end. The primary language as shown in the lexical choices shifts from a

dominance of French, in the first two sessions, to a balance between French and English in the third session, and finally a predominance of English words, which begins in the fourth session.

Of the 98 items in Bruno's lexicon at the end of the four-month period, several have representations in more than one language. Twenty lexical items occur in both French and English. Thirteen of these 20 pairs have similar representations in both languages. The other 7 are phonologically quite distinct. There are representations in Portuguese and English of two items, one for which the two are similar, agua and water, and one for which they are distinct, chave and key. The single item which has representations in Portuguese and French is quite distinct: mais and encore, meaning 'more'. The two items which appear in all three languages are: nose, nez, nariz, which are differentiated in his production, and elephant, éléfant and elefanchi, which are all produced as the same monosyllable [fɔ].

Vowel Production Frequency

The distribution of vowels in Bruno's lexical targets and the percentages of these vowels in his production, compared to the frequency of these vowels in French (from Delattre) and in English showed a definite dominance of the French vowel system in Bruno's speech production. Bruno's most frequent vowel was [a], a low front vowel in French, and the second most frequent. This vowel comprised 32% of Bruno's vowel production. In English, the low central [a] has a frequency less than .2, and does not appear among the 15 most frequent vowels. Bruno produced the high front vowel [i] in 25% of his vowel production, The high back vowel [o], which occurs in 15% of Bruno's vowel production. Although Bruno rarely produces [e], a high frequency vowel in both French and English, the high percentage of [a] corresponds to the second most frequent vowel in French.

[a] does not occur among the 15 most frequently produced vowels in English. Bruno did not produce the vowel [ɪ], the second most frequent in English, nor did it occur as a target in the first four sessions. In the second set of sessions, it occurred in a few English target words. [ae], the third most frequent vowel in English, occurred neither as a targets nor in production. [ɔ], the fifth most frequent vowel in English, only 16th most common in French, did not occur at all.

Bruno rarely produced a schwa, the most frequent vowel in English, and the fourth most frequent in French, although in the

babbling and early speech of English speaking children (reviewed in MacNeilage and Davis, in preparation), it is the most frequently produced vowel. A similar finding was reported in a study by Oller of Spanish and English speaking children (1982).

Relationship of Production to Target Vowels

The frequency of occurrence of vowels in Bruno's production corresponds closely to their frequency in his choice of target words. [a], the most frequently produced vowel, accounts for 32.8 percent of his production, and 30.9 percent of his target vowels. [i] was second most frequent, as 25.5% of production and 26.5% of targets, followed by [o], in 15.5% of production and 16.7% of targets. All vowel production followed this pattern, with no difference greater than one percent between target and production frequency.

Correctness of Vowels

Analysis of the correct production of vowels was designed to investigate two aspects of vowel production: correctness and substitutions. Each time a vowel was produced correctly, counts were made of whether it was the actual target vowel, or whether it was produced (albeit correctly) as a substitution for another vowel target. [$\tilde{\Lambda}$] was produced most correctly; it was only produced for [$\tilde{\Lambda}$] targets, and was always produced correctly. 78% of production of both [i] and [o] was correct, although [i] was produced for [i] targets only 75% of the time, and [o] for [o] targets only 73% of the time. 76% of [e] production was correct, although [e] was only produced for 41% of [e] target vowels. 66% of [ã] production was correct, yet [ã] was produced for only 54% of [ã] targets. 61% of [u] production was correct, while [u] was the vowel produced for only 42% of [u] targets. 60% of [a] production was correct, and [a] was produced for 54% of [a] target vowels. [æ] was produced correctly 33% of the time, although it was produced for 66% of [æ] targets. Least correctly produced were [$\tilde{\Lambda}$], of which only 13% of production was correct, and for which 23% of [$\tilde{\Lambda}$] targets were produced correctly. [I] was not produced correctly, nor was [ɔ] or [$\tilde{\text{ɔ}}$].

Vowel correctness, examined by word position in mono and disyllabic words showed distinct changes during the sessions. There was a 50% increase in correct vowel production in

monosyllables from the first four to the last three sessions. Correct production of the first vowel in disyllable targets, however, decreased by 50% over the same period, and the second vowel by 40%, due primarily to the increase in non-reduplicated disyllable targets. This is illustrated in Table 1, below, in which designations V1 and V2 represent the first and second vowels of disyllable words, and reduplicated indicates that the two vowels, in fact the first and second syllable, are identical.

Table 1: Overall Percent Correct of All Vowels in Each Syllable Type

Syllable Type	Session 1-4	Session 5-8	All Sessions
Monosyllable	44	69	63
Disyllable V1	89	46	56
Disyllable V2	78	54	61
Reduplicated	32	30	62

Locke (1981) comments that the high vowels are often produced with great accuracy in early speech. In monosyllables, of Bruno's three high frequency vowels, [a], [i], and [o], his most correct vowel was high, [i]. [i] was produced 95% of the time for [i] targets, and 95% of [i] targets were produced correctly. This greatly contrasts with Davis' data from a longitudinal study of vowel production of an English speaker, for whom [i] was "neither called for frequently in V1 production, nor frequently correctly produced when it was called for (38%)" (Davis & MacNeilage, 1988). In Davis' and MacNeilage's English speaker, the most frequent vowel, the schwa, was also the least correctly rendered when it occurred as a target. Bruno's most frequent vowel, [a], was almost the most frequently incorrect. Only 33% of [a] targets were produced as [a], and only 30% of [a] production was for [a] targets, although [a] occurred as a substitute for more than 15% of all vowel targets.

It is interesting to note that in Davis' subject and in Bruno's [a] production the [a] appeared most frequently in labial environments. The large percent correct for [a] in the first vowel of disyllables, 74%, may be due to the high frequency of labial-initial words, which may favor [a] production, since Bruno's most correct [a] production was after labials, and Davis' subject showed a tendency to produce [a] for other targets in labial environments. [a] was less frequently correct in the second syllable of disyllable words: 63% of targets were correctly rendered, and 45% of production was for [a] targets. The first vowel of disyllabic words was least correct for all vowels. This position effect, with the first vowel of disyllable

words the least correct in vowel production, was also found by Davis and MacNeilage. In fact, they considered the position effects, along with error rates, their main findings.

Vowel Substitutions

Bruno used a single vowel [a] to substitute for all other vowels more than 12% of the time. Davis and MacNeilage studied an English-speaking subject, who used a schwa in the same way. They concluded it was being used as a "default" vowel because of its ease of articulation. Bruno's substitutions were not with an open, central vowel. His "default" vowel is [a], a low front, lax vowel. Frequency of use, rather than articulatory ease may have determined which vowels substituted for others the most frequently, since for the English speaking children the schwa was also their most commonly produced vowel in speech.

The most frequent vowels appearing as substitutions were as follows:

1. [a] substitutes more than 12% for all except nasal targets. Range substitution: 12-57% of other target vowels.
2. [o] substitutes for 6 high front, high back and nasal Range of substitution: 1-25% of other target vowels.
3. [i] substitutes for 6 high front, low front and mid central
4. [ʌ] substitutes for 5 high front, low front, nasal and high back vowels. Range of substitution: 3-20% of other targets.

Consonant Environment

Labials were most frequent in Bruno's consonant production. Both high and low front vowels occurred frequently in labial environments.: [i] (14%) and [a] (24%) account for 38% of the vowel production in both monosyllable and disyllable words. Mid-central and nasal vowels also occurred primarily in labial environments, while the mid and high back vowels were produced more frequently in alveolar than in labial environments. Davis & MacNeilage's subject favored high back vowels in velar environments, and they suggested this might be a generalized tendency. However, Bruno favored low front vowels in the same environment. Unlike [a] production in an alveolar environment, which may have been due to articulatory constraints of early speech

development, the frequency of low vowels in velar environments may reflect their frequency in linguistic input.

Discussion

Vowel Use Across Sessions: A global approach to the overall tendencies of Bruno's vowel production across all sessions would obscure the cross-linguistic elements in the development of Bruno's speech. The diachronic evolution of his vowel preferences demonstrated what was already apparent in the development of his lexicon; he momentarily abandoned French as his language targets focused on English. In the first four sessions, Bruno's vowel production included frequent use of the front rounded vowels and the nasals characteristic of French. It is important to note that these vowels occurred clearly even in the production of English target words. At the end of the first four sessions, however, and during the second four sessions these vowels occurred much less frequently, even in English targets for which they had previously been produced. During this time the schwa began to occur, although rarely, first in babbling and then in speech,. The nasal vowels were absent from his production for two sessions. In fact, in some French words [ʌ] substituted for the front rounded vowel [œ], even though it continued to occur for English targets.

In the first four sessions, French was clearly the dominant vowel system, and the vowels which most clearly differentiate it from English, the front rounded and nasal vowels, occurred with great frequency. Even in Session IV, in which English lexical targets predominated, the French vowel system remained dominant. The French system retreated during the second set of sessions, so the appearance of the English vowels in the English targets might have been interpreted as the emergence of a dual system for the two languages. However, subsequent data, collected five months after the sessions analyzed, has shown a return to the French vowels for both French and English targets, particularly the lack of vowel reduction. Therefore, an "overload" factor, i.e., Bruno's attempt to acquire more complex word structure, introducing more two-word utterances, and possibly concentrating more on English, may have accounted for the lapse of French during the transition phase in the second set of sessions.

Consonants: If the above is the case, it should also be apparent in other aspects of Bruno's speech. The consonant data are difficult to

interpret as evidence of one system or another, since the two most characteristic features of French consonant production, final consonant devoicing and unaspirated initial consonants, occur at this stage in much cross-linguistic acquisition data, as described earlier in this section, and may be accounted for as a developmental phenomenon rather than French dominance in consonant production. For the same reason, it is difficult to isolate as specific to the onset of English the appearance of plosion and aspiration of some initial stop consonants in babbling then occasionally in speech at the end of the first four sessions.

Stress: Stress assignment varies both within and between Bruno's three languages. At the onset of the sessions, stress assignment was correct: even stress in disyllable French words (not the final syllable stress of citation forms); first syllable stress in Portuguese words. No disyllable English targets were attempted in these first sessions. Stress was correctly assigned, by either a rule for each language, or item by item rote learning. In one word, caro, stress began to vary in the second session, and continued to alternate between first syllable, second syllable, and even stress throughout the remaining sessions. Bruno's production of the uvular R in the Portuguese also changed as he shifted the stress; when he stressed the second syllable, Bruno produced the uvular R as either an h or a glottal stop. Alone with his father, speaking Portuguese, Bruno used the uvular R and the correct stress. The other variants occurred when he was in French, English, or mixed conversation, the most common in his home.

In the fourth session, the word baby was correctly produced with first syllable stress. However, the second vowel was lower and more central than the first, and different from the French production, [bebe]. Davis and MacNeilage interpreted a similar tendency, their subject's frequent use of a schwa in the second syllable of a word with first syllable stress, as evidence of the child's awareness of the unstressed syllable. Such a conclusion cannot be drawn from Bruno's speech.

Bruno appeared to have two distinct, though not completely correct, stress assignment systems after the fourth session. Even stress was produced for French lexical items and uneven stress for Portuguese and English.items. Of the three languages, only French was consistently correctly produced, possibly because of the lack of lexical stress. Although Bruno's awareness of variations in stress assignments for Portuguese and English items did not result in

correct stress assignment, variation did occur in Portuguese and English items. They were produced either with the even stress characteristic of running speech in French, or with penultimate stress.

Conclusions: How Separate are the Systems?

It is evident in these data that Bruno's speech production was characterized by dominance of a French vocalic system, despite an intermittent intrusion of English: we see this in his lack of vowel reduction, and the ongoing intrusion of French vowels in his English production after the session in which the English lexicon predominates, and even five months after these sessions. Since his consonant production paralleled general developmental tendencies, it cannot be classified as either a mixed or a dual system. The multiple representations of many lexical items, the variation in stress assignment in non-French words, compared with the consistent production of even stress in French, and the intermittent arrest of his French vowels during the second four sessions indicates Bruno is aware of the existence of multiple systems.

Bruno's speech production does not support either a separate system or a single system hypothesis. In his vowel production, Bruno's use of a default vowel, in this case a French one, was similar to that of Davis' subject, although other features of Bruno's vowel use contrast sharply with those of the vowel use of the English-speaking child. The consonant data is inconclusive, and the stress assignment, although indicative of an awareness of two systems, is not consistent enough to say two systems exist. Although the prosodic system of French is dominant, both segmentally and suprasegmentally Bruno has a mixed system within which some evidence exists of his awareness of their differences, the clearest of which may be the appearance of lexical representations in two, and, in some instances, all three of Bruno's languages.

The sociophonetic environment appears to have had a critical influence on the process of differentation and separation of Bruno's languages. Bruno's speech reflected the speech in his environment: his parents' speech in their second and third languages is influenced by their native language vowel, stress and consonant production features, so the input Bruno was exposed to is inconsistent because of errors, and different from each speaker. It is not surprising, then, that Bruno's speech between 20 and 24 months contained an

unbalanced mixture of the phonological characteristics of these three languages: the phonological characteristics of his speech were derived from his environment.

It might seem odd, then, that his lexicon does not so accurately mirror his linguistic environment. Despite the mulitiple representations of certain items, Bruno's choices of language in his lexicon did not show any particular pattern of response either to a language or an interlocutor. The frequency of English was much higher in his speech than it was in his environment. The only apparent reason for the dominance of English in his lexicon after 22 months was that English was the only language system which Bruno heard in isolation. Most children and all of the monolingual speakers in Bruno's environment spoke English. English was also the only language used by all speakers in his environment, and thus might have been identified as "universally" effective for communicating with all interlocutors.

The possibility that the language mixing, stress errors and inter-language vowel influences characteristic of Bruno's speech were idiosyncratic seems slight. Considering his sociophonetic environment, Bruno's phonological mixtures of speech system could have been directly derived from the speech he heard. Bruno's choice of English as a dominant lexicon reflects his awareness that it was the only consistent element in all speakers' lexicons. The variation in the phonological production of all languages by different mulitilingual and bilingual speakers could only confound the isolation of any one phonological system. Bruno's linguistic input was mixed, and Bruno's speech accurately reflects the mixture. Whether the mixing could be considered a system in itself, since it is his environment, remains to be explored.

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